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# SCIENCE

NEW YORK, SEPTEMBER 15, 1893.

## "CARBORUNDUM"; A SILICIDE OF CARBON.

BY WILLIAM R. BLAKE, NEW HAVEN, CONN., AND SHULLSBURG, WIS.

UNDER the name "carborundum," a new compound of carbon and silicon has been commercially introduced as an abrasive; a substitute for emery and corundum. It is a very hard crystalline solid, of a deep green color, and was obtained about the year 1890 by Mr. E. G. Acheson, of Chicago, while experimenting with the electric furnace with the intent of producing artificial diamonds. Under the supposition that he had obtained a compound of carbon and alumina he gave it the name "carborundum." Analysis,\* however, shows the following composition:

Si	-	-	-	-	-	69.10
C	-	-	-	-	-	30.20
Al <sub>2</sub> O <sub>3</sub> and Fe <sub>2</sub> O <sub>3</sub>	-	-	-	-	-	0.49
CaO	-	-	-	-	-	0.15

Which may be expressed by the formula SiC; the other substances being regarded as impurities, and as imparting the color, which is found to be variable, from nearly white to a deep green and blue.

At a session of the Academy of Sciences of France, May 16, 1892, M. P. Schützenberger described the production of a new compound with the same formula.† It appears, however, that some carborundum had previously been molded into buttons and mounted in bulbs for electric lighting and exhibited by Mr. Nikola Tesla before the Institution of Electrical Engineers in London in the month of February, 1892, but its composition was not then known.

The value of this substance as an abrasive has led to its manufacture upon a large scale, and its introduction in the form of powders of different degrees of fineness, and of wheels and whetstones and polishing cloths.

The processes of manufacture are described in the memoir cited and also in another by the inventor,‡ which gives illustrations of the furnace, which consists merely of a rectangular box, about six feet long, eighteen inches wide and a foot deep, built up of fire brick, in which a mixture of sand and carbon is exposed to the electric current for eight hours. The result is a mass of crystals of small size, which is crushed, and the powder is digested with dilute sulphuric acid to remove impurities.

The crystallization has been carefully studied by Prof. B. W. Frazier, of Lehigh Univ., who finds it to be rhombohedral, and in some cases hexagonal. Both direct and inverse rhombohedra were observed and determined, viz.: 1-5, 4-5, 10-11, 1, 5-4, 4-3, 10-7, 2, 5-2, 4, 19-4, 5, 10. In some crystals the direct and inverse rhombohedra of the same parameters were found on the same crystal, so as

to impart to it an appearance of holohedral hexagonal symmetry.

The value for the length of the vertical axis is given as,  $C = 1.2264$ .

In the crystals which I have examined the tabular habit prevails, and as seen under the microscope they consist of hexagonal plates with the rhombohedral planes too small to permit of their inclination being measured.¶

The specific gravity of a bluish-green colored mass as determined by myself at 60 F. was found to be 2.546. Prof. J. W. Richards found it to be for the green crystals 3.123, and for the blue somewhat less.

The hardness, which is the most important character industrially, lies between the sapphire and the diamond, and may thus be expressed by  $9\frac{1}{2}$ . It is claimed by the inventor that the powder on a rapidly revolving lap will cut and polish the diamond, and he believes that it may be advantageously substituted for diamond dust in diamond cutting.

It is a good conductor of heat, and is not fusible before the blow-pipe. It also resists all acids, even the fluoric, and does not burn when heated in a current of oxygen; this being one of the methods adopted to obtain it free of any graphitic carbon.

The color and lustre are remarkably brilliant, and if by any modification of the process large and solid crystals can be made, we shall have a valuable addition to our list of gems.

Considering the abundance of these two elements in nature, both silicon and carbon, and the comparatively indestructible nature of the compound formed by their union, it is surprising that we do not find this compound in nature. Its absence indicates the prevalence of conditions during the formation of the crust of the earth unlike those of the electric furnace.

## LATTER-DAY TAXIDERMY.

BY VERNON L. KELLOGG, ITHACA, N. Y.

TAXIDERMY is hardly recognized as one of the fine arts, yet. Perhaps it may never be. But the truthfulness of representation, and the artistic effects of posing and grouping which "mounted" animals may exhibit, can often invest such work with an interest for those who may not be much inclined toward taxidermy for the sake of the skin-preserving. The displays of mounted birds and mammals at the World's Fair present several stages of progress in the art of taxidermy, and lead one to speculate on the outcome of it all. For scientific purposes, *sensu stricta*, the making of birdskins is probably preferable to attempting the mounting of the specimens; and so perhaps with many of the mammals. Evidently, however, if the specimen in hand can be truthfully represented so far as form and characteristic position and externals go it may serve as a teaching object to many to whom the "made" skin, with accompanying written measurements, may be without a lesson.

But it seems as if it were possible to go even farther:

\*By Dr. Mulhaeuser, chemist of the Carborundum Company, in Memoir by E. G. Acheson: "Carborundum, Its History, Manufacture and Uses," Jour. Frank. Inst., Philadelphia, Pa., Sept., 1893.

†Contribution to the History of Carbo-silicious Compounds.

‡Carborundum, etc., The Electrical Engineer, XV., p. 227, March, 1893.

¶From a Report to the Carborundum Co., Memoir cited. Appendix, p. 19.

¶ Vide Article in Eng. Min. Jour., Sept., 1893.

not only shall the restored animal act as a lesson in zoölogy, a reference object which may impress on the student-naturalist the peculiar characteristics of the animal species represented, but the restoration may possess the power of displaying the emotions and passions; it may be beautiful; it may, in a word, appeal to the human sense just as a figure in marble or bronze or staff may. The analogies, too, between sculpture and latter-day taxidermy, in matters of technique, are striking. The sculptor makes his model in clay, and often enough, now-a-days, is done with it.

Italian artisans are clever enough to carry on the work of reproduction even to the final touches on the marble. The man mounting an elk makes a model so complete in detail that the putting on of the skin does hardly more than add color and the effect of hair to his statue. A wooden frame, a rough wrapping of tow and twine, and over all the plastic clay giving truthful detail of form, and life, compose the model. The shapeliness of the limbs, with loose or swelling muscles, the rigid tendons, the sunken flanks, the projecting angles of the pelvic and shoulder girdles, the expressive lines of the eyes and nose and mouth, all exist in the model. Over this is drawn the skin, which fits because it does fit, and which is only a bit of realism added by the sculptor-taxidermist to his model. The traditional "stuffing" is truly a matter of tradition.

The taxidermist who is a naturalist and has thoroughly studied his subjects; who is an anatomist and is true, in his work, to structural detail; who has seen his animals walk and crouch and leap, not in cages alone, but in the forest and canon; and who perceives the look of fear or defiance, the attitude of cunning or of ferocity or of pain, and carries these expressions and poses ever in his eye, to be faithfully reproduced in his restoration, is equipped as the sculptor of animals must be equipped. And taxidermy by such a taxidermist comes near to being fine art.

Among the World's Fair displays of taxidermic work a notable one is that made by the University of Kansas, in the Kansas State Building. This building was planned with special reference to the displaying of this collection, and the arrangement adopted is an effective one. The collection comprises 109 mounted specimens of North American mammals, and contains several groups, as those of the Rocky Mountain Goats and the American Bison, of special value, from the zoölogist's point of view. But the rare excellence of the taxidermic work in this collection should attract a more general interest than that of the zoölogist alone. The work was done by Lewis L. Dyche, professor of zoölogy in the University of Kansas, and a majority of the specimens were personally obtained by him in a number of collecting expeditions. Some striking groups will repay critical study. In the fighting of two moose, the faithful adherence to anatomical detail, as shown in the contracted muscles, the carefully disposed limbs, and the skilful arrangement of the heads, is no more in evidence—in fact, at first glance is far less striking—than the artistic effect of the whole. The fury and extremity of exertion of the struggling animals is impressive. In a single magnificently-antlered elk the poise, the fine contour of the body, the speaking expression of the head and face are that of unconscious superiority. A snarling wolf has a head whose modelling is a work of genuine fine art. And the fine art of truth of detail is not neglected for the whole's effect. In the Art Galleries at the World's Fair there are many excellent pieces of animal sculpture, but a critical analysis will betray in some of them a woful ignorance of mammalian anatomy on the part of the sculptor, or a wilful distortion of it by him. For example, a reclining panther, with young, on

the whole a fine piece, and singularly expressive, has the lower portions of the hind legs absurdly lengthened. Again, and often, the sculptor, to show that he really has anatomical detail in mind, has practically "skinned" his animals. A lion, in staff, at one of the entrances, and a panther, in bronze, within, are examples of this peculiarity. But in sculpture, probably, the effect is the primary intention; in taxidermy, truthful reproduction is the primary intention. Where, however, the mounted animal may not only be an object of scientific value as a truthful restoration, but may be possessed of the attributes of a work of fine art, the combination is a happy one. That such a combination is possible the writer believes some of Professor Dyche's animals prove.

#### NOTES AND NEWS.

—"Inductive Psychology," by E. A. Kirkpatrick, is an outline of the science prepared for use in the author's classes in the State Normal School of Minnesota, and bears the imprint of Jones and Kroeger, Winona, Minn. It treats of the elements of the subject only, and some of them are so briefly dealt with that the book will hardly serve for those who study without a teacher; but for classes whose teacher is capable of expanding the hints that are plentifully scattered through the book it will be useful. It opens with a brief account of what psychology is and of the proper method of studying it, and then proceeds to treat first of the general powers of the intellect, consciousness and attention, and afterwards of the various special powers, such as perception, memory, etc. The author's expression is direct and simple, and, considering the smallness of the book, the elucidation of the various topics is remarkably clear. The views presented are, in the main, those that have stood the test of time; and we notice in particular that Mr. Kirkpatrick lays little stress on physiological methods, and apparently has little faith in their efficacy. On one point we are compelled to differ with him. He alleges in his preface that psychology has hitherto been taught deductively, and he seems to think that his own "inductive" method is something in great part new; but we have never seen a deductive psychology such as he speaks of, and we can see no essential difference between his method and that of previous writers. The best feature in the book is the numerous hints to teachers as to the best mode of studying the psychology of their pupils, a feature that makes the work specially available in the training of teachers.

The translation of Windelband's "History of Philosophy" by Professor Tufts, of the University of Chicago, will be published about the third week of September by Messrs. Macmillan & Co. The advance sheets now ready indicate that the work will prove a valuable addition to available English records of the development of scientific conceptions of nature and human life. It will be published in one volume of about six hundred pages.

ADDITIONAL announcements of books to be published this fall by the Macmillans are: "Pain, Pleasure, and Æsthetics": An Essay Concerning the Psychology of Pain and Pleasure, with special reference to Æsthetics, by Henry Rutgers Marshall, M.A.; an annotated edition of the *Adelphoe* of Terence, by Prof. Sidney G. Ashmore, of Union College, Schenectady; a new edition with vocabulary and notes of Zupitza's "Old and Middle English Reader," upon the vocabulary of which Prof. MacLean, of the University of Minnesota, has been at work for some years, making it very complete and accurate; and a volume of "Chronological Outlines of American Literature," on the plan of, and uniform with, Mr. Ryland's "Outlines of English Literature."